EFFECT OF THE NITRIFICATION INHIBITOR DMPP APPLIED WITH MINERAL FERTILISER AND CATTLE SLURRY ON YIELD AND N UPTAKE FROM GRASSLAND

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ABSTRACT

A field study was conducted to assess the effect of the nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP) on forage production and N uptake from slurry applications in comparison to mineral ones in grassland systems of the Basque Country. Two kinds of fertilisers were applied: mineral (M) as ammonium sulphate nitrate 26% (19.5% ammoniacal and 6.5% nitric) and cattle slurry (S). DMPP (1 kg ha^{-1}) was used or not with both types of fertiliser. Following each fertiliser application grassland yield was assessed. Grass was dried in a forced-air oven at 70ºC for at least 48 h, weighed, and then ground. Nitrogen concentrations were performed on dried and ground herbage using a Macro Kjeldahl method. In our experiment, the use of DMPP did significantly increase biomass yield and N uptake (Table 4) in mineral fertilization. Botanical composition was not affected by the use of DMPP.

Keywords: *fertiliser, nitrification inhibitor, grassland yield, N uptake.*

INTRODUCTION

Nitrogen affects plant yield and quality like no other plant nutrient, but its excessive application by farmers may have unwanted effects on the environment. In intensively managed crop production, the utilisation rate of mineral fertiliser N is only 50-70% of that applied (Wiesler, 1998). Nitrification inhibitors (NI) are compounds that delay the bacterial oxidation of ammonia to nitrite in the soil (first step of nitrification) for a certain period of time by depressing the activity of *Nitrosomonas* bacteria in the soil., thus delaying the oxidation of the ammonium present in the fertiliser into nitrate for a certain period of time. Pasda et al. (2001) have reported yield increases in many crops, except in spinach, as well as a negative effect on the crude protein concentration of winter wheat. In general, these alterations in yield are a consequence of the change from nitrate to ammonium nutrition which the plant is subjected to (Britto and Kronzucker, 2002; Frechilla, 2002)

Since nitrate is the major source of the environmental problems related to soil N dynamics (nitrate leaching, denitrification) and nitrate comes from nitrification, NI´s are of interest for being highly effective in blocking N_2O emissions from nitrification. This is specially so in grasslands of the Basque Country, where it has been found that most of the fertiliser N applied to soils is oxidised quite rapidly to nitrate by nitrifying microorganisms (Merino et al., 2002). Moreover, in the grasslands of the Basque Country (northern Spain), there is a high risk of N losses to the atmosphere due to high rainfall (typically in excess of 1000 mm yr^{-1}) and warm temperatures, specially in spring and autumn when fertiliser is applied (Estavillo et al., 1997; Merino et al., 2001). The aim of the present study was to assess DMPP effect on forage production and N uptake in a permanent pasture fertilised with mineral or dairy cattle slurry in autumn and spring

MATERIALS AND METHODS

Experimental plot

In autumn 2002 and spring 2003 a randomised complete block factorial design (4x3m single. plot and 4 blocks) was carried out on a grassland site at Derio (Bizkaia, Spain). A typical permanent pasture (*Lollium perenne* L.var. Herbus, 60%; *Lollium hibridum* L. var. Texi, 32%; *Trifolium repens* L.var .Huia, 8%) was sown at a density of 40 kg seeds ha-1 in April 2001. Rainfall and maximum and minimum temperatures recorded for the period of this study are shown in Table 1.

***Table 1**. Fertilisation dates and rates of fertiliser application, slurry characteristics and climate characteristics after each fertiliser application period.*

	1st application	3rd application
Date of fertilizer application	8th October 02	19th May 03
N application rate (kg Nha^{-1})	135	97
Climatic characteristics	8th October 02-18th March 03	18h May-17th July
Rainfall (mm)	162.7	113.1
Soil Ta (min-max ºC)	2.6-15.8	12.8-21.5
Air Ta (min-max ºC)	1.3-20.1	13.3-27.5

Two kinds of fertilisers were applied: mineral (M) as ammonium sulphate nitrate 26% (19.5% ammoniacal and 6.5% nitric) and cattle slurry (S). DMPP (1 kg ha^{-1}) was used or not with both types of fertiliser. On the one hand, as the commercial fertilizer Entec® 26 (18.5% ammoniacal and 7.5% nitric with 0.8% DMPP of N applied) (M+DMPP) and, on the other hand, mixed with the slurry (S+DMPP), 0.8% of the N applied. A treatment with no fertilizer was included as a control (C). Fertiliser application rates are shown in Table 1. The treatments were as follows: C) Control, M) Ammonium sulphate nitrate 26%, M+DMPP) Entec® 26, S) Cattle slurry, S+DMPP) Cattle slurry + DMPP.

Following each fertiliser application grassland yield was assessed. Grass yield was measured on one randomly chosen area of 4.5 m^2 per plot. Grass was dried in a forced-air oven at 70ºC for at least 48 h, weighed, and then ground. Nitrogen concentrations were performed on dried and ground herbage using a Macro Kjeldahl method.

RESULTS AND DISCUSSION

Using nitrification inhibitors does not always result in increased crop yields (Scharf and Alley, 1988). In our experiment, the use of DMPP did significantly increase biomass yield and N uptake (Table 2) in mineral fertilization.

***Table 2**. Total yield, N uptake and percentages of clover, ryegrass and other species with mineral fertiliser with and without DMPP and an unfertilized treatment (Control).*

Treatment	kg DM ha^{-1}	% N	Kg N ha^{-1}	Clover (%)	Ryegrass (%)	Other species (%)
C	5661 b	2.9 c	153.5c	17.1a	58.5 b	24.3 a
M	6804 ab	3.3 b	225.2 b	3.9 b	79.6 a	19.5 a
M+DMPP	8764 a	3.5 a	306 a	3.2 b	70.7 ab	25.3 a

***Table 3**. Total yield, N uptake and percentages of clover, ryegrass and other species with slurry fertiliser with and without DMPP and an unfertilized treatment (Control).*

Treatment	Yield (kg DM ha^{-1})	N content (%)	N extraction (Kg N ha^{-1})	Clover content (%)	Ryegrass content (%)	Other species content (%)
C	5661 b	2.9 a	153 b	17.1 a	58.5 a	24.3 a
S	9063 a	2.9 a	230 a	6.6 b	61.2 a	32.3 a
S+DMPP	8190 a	2.8 a	215 a	9.8 b	66.3 a	29.3 a

Botanical composition was not affected by the use of DMPP in any type of fertiliser. In this sense, it was the supply of N in both M and S treatments what significantly decreased the percentage of clover with respect to control treatment, similarly to what it was observed by Whitehead et al (1983), Frame and Boyd (1987) and Davies (1992). Percentage of ryegrass was increased if mineral fertilisation was used, regardless of the use of DMPP.

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